<u>REMARKS</u>

The present invention relates to a ceramic heater useful for preparing semiconductors. The presently-pending claims contain all the limitations of Claims 11 and 14 of the parent application, as of the amendment filed June 2, 2003.

As described in the specification under "Background Art" beginning at page 1, line 8, it is known in the prior art to use ceramic heaters containing resistance heating elements on a surface thereof for heating semiconductor wafers and the like. Conventional heaters, having a resistance heating element in a pattern such as that shown in Figure 5 herein, results in non-uniform heating, and thus the semiconductor wafer or the like to be heated suffers from unevenness in temperature.

A ceramic heater comprising a disc-shaped non-oxide ceramic substrate and a resistance heating element has a problem that the temperature in the peripheral portion tends to drop since a non-oxide ceramic has high thermal conductivity and the heat thereof easily radiates from the ceramic substrate or atmospheric gas deprives the ceramic substrate of heat.

In the meantime, heat tends to accumulate in the central portion of the ceramic substrate, so that the temperature in the central portion tends to rise.

Accordingly, in a ceramic heater comprising a non-oxide ceramic substrate with high thermal conductivity, a temperature difference between the central portion and the peripheral portion is generated. There arises a problem that the temperature of the heating surface does not become uniform.

The present invention successfully addresses these deficiencies of the prior art.

As recited in independent Claim 1, the present invention is a ceramic heater, comprising a resistance heating element arranged on a surface of a disc-shaped non-oxide ceramic substrate or inside the substrate, wherein the resistance heating element is divided into two or more circuits and comprises a mixture of a resistance heating element having a

concentric or spiral pattern and a resistance heating element having a pattern of a winding line, and wherein the resistance heating element having the pattern of the winding line is formed at least in a peripheral portion of the substrate.

As recited in independent Claim 2, the present invention is also a ceramic heater, comprising a resistance heating element arranged on a surface of a disc-shaped non-oxide ceramic substrate or inside the substrate, wherein the resistance heating element is divided into two or more circuits and comprises a mixture of a resistance heating element having a concentric or spiral pattern and a resistance heating element having a pattern of repeated winding lines, and wherein the resistance heating element having the pattern of the repeated winding lines is formed at least in a peripheral portion of the substrate.

Thus, all the present claims are characterized by the presence of a non-oxide ceramic substrate, division of a resistance heating element into two or more circuits, and the resistance heating element having either a pattern of a winding line (Claim 1) or repeated winding lines (Claim 2) formed at least in a peripheral portion of the substrate. With this structure, heat density in the peripheral portion is maintained high, and the temperature thereof does not drop. The temperature uniformity of the whole wafer-heating surface is thus improved.

It is an essential prerequisite of the present invention that the ceramic heater comprises a non-oxide ceramic substrate. In addition, the present invention requires two indispensable features: a resistance heating element having a concentric or spiral pattern; and a resistance heating element having a pattern of a winding line or a pattern of repeated winding lines in the peripheral portion where the temperature tends to drop. The above-discussed property of temperature uniformity cannot be attained in the absence of either feature.

The above is neither disclosed nor suggested by the applied prior art.

The rejection dated July 29, 2003 in the parent application of Claims 11 and 14 under 35 U.S.C. §102(b) as anticipated by U.S. 5,616,024 (Nobori et al), should not be repeated herein.

Nobori et al disclose a ceramic heater comprising a ceramic substrate and a resistant heating element embedded within the substrate along a predetermined planar pattern, wherein the resistant heating element is obtained by heat-treating a convolution of a high melting point metallic, spiral-coiled filament at a temperature not higher than a primary recrystallization commencement temperature of the high melting point metal under a non-oxidative atmosphere, while the convolution is held in and along the predetermined pattern. See Claim 7 therein. In Nobori et al, the resistant heating element is preferably divided into a peripheral portion and an inside portion of the substrate, which can control the heat radiation value of each of the resistant heating elements in respective portions, independently. In addition, in Figures 16 and 17 therein, two heating zones are supplied (column 21, line 55 through column 22, line 56). However, all of the resistant heating elements of Nobori et al are in a pattern composed only of a spiral convolution. Nobori et al neither discloses nor suggests the presently-recited mixture of Claims 1 or 2. In a pattern such as disclosed by Nobori et al, transmission of heat in the direction of the heater diameter becomes small and transmission of heat in the direction of the heater circumference becomes large. Thus, unevenness of temperature would be expected from Nobori et al's configurations.

Contrary to the Examiner's findings, the resistant heating element according to Nobori et al does **not** comprise a pattern of a winding line. For example, Fig. 3b is a **plan view** of a convolution 13. The convolution 13 is produced from the spiral **coil** (column 11, lines 46-48). The loops 13b, which look like winding lines, have an increased distance between **successive coils** (column 11, lines 56-58), and thus do not have a pattern of a winding line. Therefore, the central portion and the peripheral portion of the ceramic substrate thereof both

comprise a resistant heating element having only a spiral pattern. With such a structure, heat density in the peripheral portion is low, and temperature drop in the peripheral portion cannot be suppressed.

For all the above reasons, it is respectfully requested that this rejection not be repeated

The rejection dated July 29, 2003 in the parent application of Claims 11 and 14 under 35 U.S.C. §103(a) as unpatentable over U.S. 2,409,244 (Bilan) in view of U.S. 6,225,606 (Tsuruta et al) or U.S. 6,080,970 (Yoshida et al), and further in view of U.S. 4,645,911 (Husslein) or U.S. 4,577,176 (Bayer), should not be repeated herein.

Bilan discloses a heater comprising a glass plate 10, an electric wire coil 12 of high resistance metal embedded therein, which is concentrically arranged, and a plurality of annular ridges, the plate being provided with a plurality of spaced openings. As shown in the figures therein, the coil is concentrically arranged and has the shape of a winding line. However, glass is an oxide. Thermal conductivity of oxide ceramics is generally lower than that of non-oxide ceramics. Thus, the glass plate 10 is different from, and not suggestive of, the non-oxide ceramic substrate of the present invention. Therefore, Bilan is silent both about the problem specific to a non-oxide ceramic substrate and Applicants' solution thereof, which is the above-discussed structure. In other words, one cannot predict from Bilan the problem that the temperature in the peripheral portion of a non-oxide ceramic tends to drop, and that the above-mentioned two features are both necessary to attain the temperature uniformity of the whole wafer-heating surface. Moreover, the electric wire coil 12, which is not divided into two or more circuits, has the same pattern of repeated winding lines both in the central portion and the peripheral portion of the plate. Therefore, the heat density in the peripheral portion cannot become higher than that in the central portion, and the temperature uniformity of the plate cannot be attained. Accordingly, the hotplate according to Bilan is different in structure from the ceramic heater according to the present invention.

Tsuruta et al discloses a ceramic heater, wherein a resistance heating element thereof contains a network member having a circular or spiral pattern (Figs. 2b, 6a and 7a). However, it does not have both a pattern of a winding line and a spiral pattern. Nor is Tsuruta et al's resistance heating element divided into two or more circuits.

Yoshida et al discloses a wafer heating apparatus comprising a ceramic substrate. The heater pattern shown in Yoshida et al is a concentric pattern, not a winding line. With such a structure, uniform heating cannot be realized. In addition, as shown in Fig. 3, the temperature in the peripheral portion of the substrate is within the range of 471 °C to 474 °C, and the temperature in the central portion of the substrate is within the range of 474 °C to 477 °C; thus, the average temperature is 474 °C. The temperature difference therefore is 6 °C, equal to 1.26% of the average temperature. On the other hand, the ceramic heater of the present invention, as exemplified by Examples 1-3 of the specification, shows a temperature difference of not more than 0.5 °C with the temperature of the central portion being 200 °C. This temperature difference is equal to only 0.25% of the temperature of the central portion. Thus, the ceramic heater of the present invention is superior in uniform heating. Nor does Yoshida et al disclose or suggest dividing into two or more circuits.

Husslein discloses a heating device comprising a glass-ceramic plate and heating elements. Husslein thus neither discloses nor suggests the non-oxide ceramic substrate of the present invention, nor the particular problems associated with non-oxide ceramic substrates, and Applicants' solution thereto, all as discussed above. Moreover, in the heating devices shown in Figs. 1, 3 and 4, heating elements in the peripheral portion of the plate do not have a pattern of a winding line, but have a circular or concentric pattern. Therefore, heat density in the peripheral portion cannot become higher than that in the central portion, and the temperature uniformity of the plate cannot be attained. Accordingly, the heating device

according to Husslein is different in structure from the ceramic heater according to the present invention.

Bayer discloses a heating appliance comprising a plate 5 of metal or glass-ceramic (col. 3, lines 40 to 42). Bayer thus neither discloses nor suggests the non-oxide ceramic substrate of the present invention, nor the particular problems associated with non-oxide ceramic substrates, and Applicants' solution thereto, all as discussed above. In addition, as shown in Fig. 2 therein, heating coil 3' embedded in the peripheral portion of the composition 4 does not have a pattern of a winding line, but of a concentric pattern. Therefore, heat density in the peripheral portion cannot become higher than that in the central portion, and thus, temperature uniformity of the plate cannot be attained.

Thus, even if Husslein or Bayer, and Tsuruta et al or Yoshida et al, were combined with Bilan, the result would not be the presently-claimed invention.

Nor without the present disclosure as a guide would one skilled in the art have combined Bilan, Husslein or Bayer, and Tsuruta et al or Yoshida et al.

For all the above reasons, it is respectfully requested that this rejection not be repeated.

The application is now ripe for examination on the merits. An early examination is respectfully solicited.

Respectfully submitted,

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